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17 February 1964

MEMORANDUM FOR: Deputy Director, Science and Technology
THROUGH : Deputy Director, Intelligence
SUBJECT : Establishment of a Scientific Investigative Working
Team to Determine Standards for Measuring Technical
Quality of Aerial Photography.

1. PROBLEM

To institute a program through which, by establishing standard measurable parameters, a correlation can be made between the image quality for interpretation, and the monitored variables used by systems designers for defining performance of inflight components.

2. FACTS

a. The findings of the Photo Working Panel (Drell Panel) on the Corona/Mural System have indicated the extreme urgency of defining some means for the characterization of performance which can be used by engineers and scientists associated with reconnaissance systems.

b. The findings of this panel indicated that no suitable objective standards currently exist.

c. The panel recommended that first priority be given to the study of an edge measurement standardization program. To this end the panel prepared a work statement to guide the investigation.

d. National Security Council Intelligence Directive No. 8, charges the NPIC with responsibility for sponsorship of development of specialized equipment for the intelligence exploitation of photography. The scientific knowledge upon which this specialized equipment development is based, and

the procedures for the use of such equipment are a fundamental part of this responsibility.

3. DISCUSSION

a. NPIC accepts and endorses the findings of the Drell Photo Working Panel. It has supported this group throughout its three month study of the Corona/Mural System. Past and current projects performed or sponsored by the Plans and Development Staff contributed to the fund of knowledge upon which the Panel based its findings.

b. Some investigation and development are at present underway, under the sponsorship of NPIC, which are expected to contribute valuable inputs toward the ultimate solution of the stated problem.

(1) These efforts include a study with [] concerning the effects of film processing on edges as measured through microdensitometer procedures. The study includes the effects of developer composition on photographic edge characteristics, as evidenced through microdensitometric edge trace and analysis of the edge through acutance, and granularity. Variation in these characteristics will be achieved through changing the developer components. The edges will be processed through two stages, using the equipment which is ordinarily used for processing mission film; duplication will take place under similar circumstances. The results will directly bear on the use of material ordinarily delivered to NPIC. Questions of where the "true" edge lies after several positive-negative printings will also be considered, so that the problem inherent in mensuration may be more clearly outlined.

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(2) A microdensitometric capability and data interpretation study at [REDACTED], is being pursued. This study will provide a text for instruction and reference for personnel engaged in extraction of information through microdensitometry. The resulting text will ensure the use of any microdensitometer to its maximum capability, including complete and accurate interpretation of all data. Information contained in this text will be current and thus reflect the most recent knowledge in the field of microdensitometry.

(3) Evaluation and Calibration Standardization for Microdensitometers by National Bureau of Standards. At present there is no acceptable standardized calibration technique and because density measurement varies with procedure and instrument, calibrations are neither reproducible nor generally reliable. This effort is expected to produce an approved standard for calibration which would eliminate erroneous interpretation and duplication of effort in the future on both operational and research programs.

(4) A Staff effort and negotiations have been conducted since November 1963 for investigation into the parameters, and equipment for measuring these parameters, to be used in the determination of the technical quality of photo images. A contract has not yet been negotiated on this problem but was programmed for this fiscal year. [REDACTED]

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[REDACTED] was considered the most likely vendor.

c. NPIC maintains an Exploratory Development Laboratory capable of determining the feasibility of many concepts relating to the technical

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quality of photographic images. Feasibility determinations by this Laboratory have, in the past, avoided the pursuit of unprofitable developments. The collateral support of this Laboratory in the solution of the subject problem is essential to economy and expeditious accomplishment of the investigations proposed in this program.

d. It is the collective opinion of the Plans and Development Staff, NPIC, that other measurements or analytical techniques not involving edge analysis may prove to be more suitable as a result of further investigation. It, therefore, follows that the work statement for the subject investigation should not rule out other techniques of equal or improved precision which may or may not involve edges.

e. The procurement office within CIA has been informed of the impending contractual actions and are prepared to negotiate the required contracts.

4. CONCLUSIONS

a. That a scientific investigative working team would provide the most effective and expeditious means of accomplishing the required work.

b. That NPIC has the responsibility and the ability to sponsor this program and bring about successful results.

c. The findings of the Drell Photo Working Panel indicate that there still remains a need to construct an objective and quantitative measure of image quality that is both reliable and operationally practical. The means for satisfying this need leads to the following recommendations.

5. RECOMMENDATIONS

a. That NPIC sponsor a working team comprised of the following nationally recognized experts in the field of image evaluation to help orient and direct the procedures and techniques necessary to solve the stated problem.

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b. That the working team meet at the NPIC, on the earliest possible date, to amplify, orient and direct the actual procedures and techniques to be followed in the program. The members of the team would then return to their respective laboratories to guide the work specified for each laboratory.

c. That the work statement attached provide the initial guidance to the team in accomplishing the following objective: To develop and validate a procedure for applying microdensitometer edge trace analysis (or any other analytical technique of equal or improved precision which may or may not

involve edges) to estimating the technical quality of aerial photography. The method should be suitable for routine production using automated procedures, but expediency must not be substituted for accuracy.

d. That NPIC sponsor, under the authority and responsibility contained in para 2g, NSCID No. 8, USIB, the contractual and in-house effort required to achieve the stated objective of this program. The proper contracting personnel have been informed of the program and are prepared to support the contractual negotiations required in an expeditious manner.

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ARTHUR C. BONDALL

Director,
National Photographic Interpretation Center

Attachment: A/S

TOP SECRET

Work Statement

Edge Measurement Standardization Program

Object

To develop and validate a procedure for applying microdensitometer edge trace analysis (or any other analytical technique of equal or improved precision which may or may not involve edges) to estimating the technical quality of aerial photography. The method should be suitable for routine production using automated procedures, but expediency must not be substituted for accuracy.

Organization

1. A working team headed by [] will be organized to carry out the work. [] is a scientist of recognized professional reputation in the field of photographic measurement. This team is made up of representatives of industrial and Government laboratories actively engaged in edge measurement and data reduction. A joint experimental program will be carried out by team members working in their individual laboratories. The team shall meet regularly both to plan the technical work and review the results obtained. The program will be periodically revised based on results, so as to reject as quickly as possible those methods of limited promise and to arrive expeditiously at agreed upon procedures. While the work should proceed with a certain sense of urgency, no compromise should be made with the requirement for a truly scientific approach to the problem. The program should be unclassified.

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Task Outline

Phase I - Planning

1. Conduct a review of work carried out to date both published and unpublished.

2. Review and analyze the character of microdensitometers available to team members.

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commercially available instruments considered suitable for edge analysis.

3. Recommend the laboratory and define the work to be accomplished by that laboratory in support of the objective.

4. Review in depth other potential quantitative measures of image quality to be investigated in the event that correlation between image quality and Laboratory edges proves inadequate.

Phase II - Laboratory Edges

1. Specify and prepare sample edges for circulation among members. The edges must be prepared by calibrated image forming systems with a variety of known transfer functions. Emphasis should be placed on 4404 film, but a second film 4400 should be included for comparison.

2. Circulate sample edges among laboratories for measurement and data reduction in accordance with the procedure or procedures preferred by each laboratory. Edge trace data obtained by laboratories should be circulated so that the data reduction techniques used by other laboratories can be applied.

3. Following this, and guided by a review of the results of the first circulation, to recommend modifications of technique as needed and repeat the experiment. This procedure should be continued until a consensus is achieved on proper procedure.

4. Evaluation of results must at all times be guided by appropriate statistical measures of systematic and random errors.

5. Techniques should be rejected that are not susceptible to application by trained technicians in a routine way.

Phase III - Operational Edges

1. Apply the techniques approved in Phase I to edges in actual aerial photographs.

2. Analyze these results statistically in order to determine the accuracy and reliability possible under different conditions.

3. Outline procedures necessary to ensure the selection of edges (density, straightness, sharpness, etc.) suitable for measurement.

Report

The team shall prepare a report which (a) describes the work carried out by the team, (b) recommends operational techniques and procedures and (c) describes the accuracy and reliability possible in measurements up to levels at least corresponding to 200 lines/mm at 2:1 contrast.

The report will include a discussion of the errors introduced as a function of instrumentation, procedure and resolution level, thus providing firm guide lines which will govern the long-term routing application and interpretation of edge trace data.

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